

# BUOYANCY STRUCTURES IN RHABDOSOMES OF *DICTYONEMA* *FLABELLIFORME* (EICHWALD)\*

O. M. B. BULMAN & L. STØRMER

Bulman, O. M. B. & Størmer, L.: Buoyancy structures in rhabdosomes of *Dictyonema flabelliforme* (Eichwald). *Norsk Geologisk Tidsskrift*, Vol. 51, pp. 25–31. Oslo 1971.

Additional examples of *Dictyonema flabelliforme* provided with a 'basal organ' at the proximal end are illustrated and described, and the interpretation of this as a buoyancy structure is discussed.

*O. M. B. Bulman, Sedgwick Museum, Cambridge, England. L. Størmer, Institutt for Geologi, University of Oslo, Oslo, Norway.*

## Introduction

In 1933, a rhabdosome of *Dictyonema flabelliforme* (*D. f. anglica*) was described which terminated proximally in a rounded disc completely obscuring the sicula and earliest thecae. This was interpreted (Størmer 1933, p. 111) as the cuticular wall of a sphaeroidal pneumatocyst or floating organ, probably analogous to the discoidal web-like central disc of *Dichograptus*, the sphaericity being essentially a consequence of the pendent branches of the *Dictyonema* rhabdosome. Two years later (Størmer 1935) two further examples probably *D. f. flabelliforme*, were described in which the 'basal organs' were more fusiform in outline, enclosing or enveloping the sicula but not incorporating the primary stipes to an appreciable extent. These specimens were regarded by Bulman (1938, p. 13) as exceptional, possibly involving regeneration or perhaps representing compression of a disc of attachment on a short-stemmed rhabdosome; and even in 1964 (p. 466, footnote) he considered them as abnormalities. The purpose of this note is to put on record the existence of between 20 and 30 rhabdosomes possessing such structures, mainly collected by Professor Størmer in the Oslo region before and during the war.

It is not suggested now that this represents a common condition, for the exposed and unmodified sicula remains by far the more usual state: 'hun-

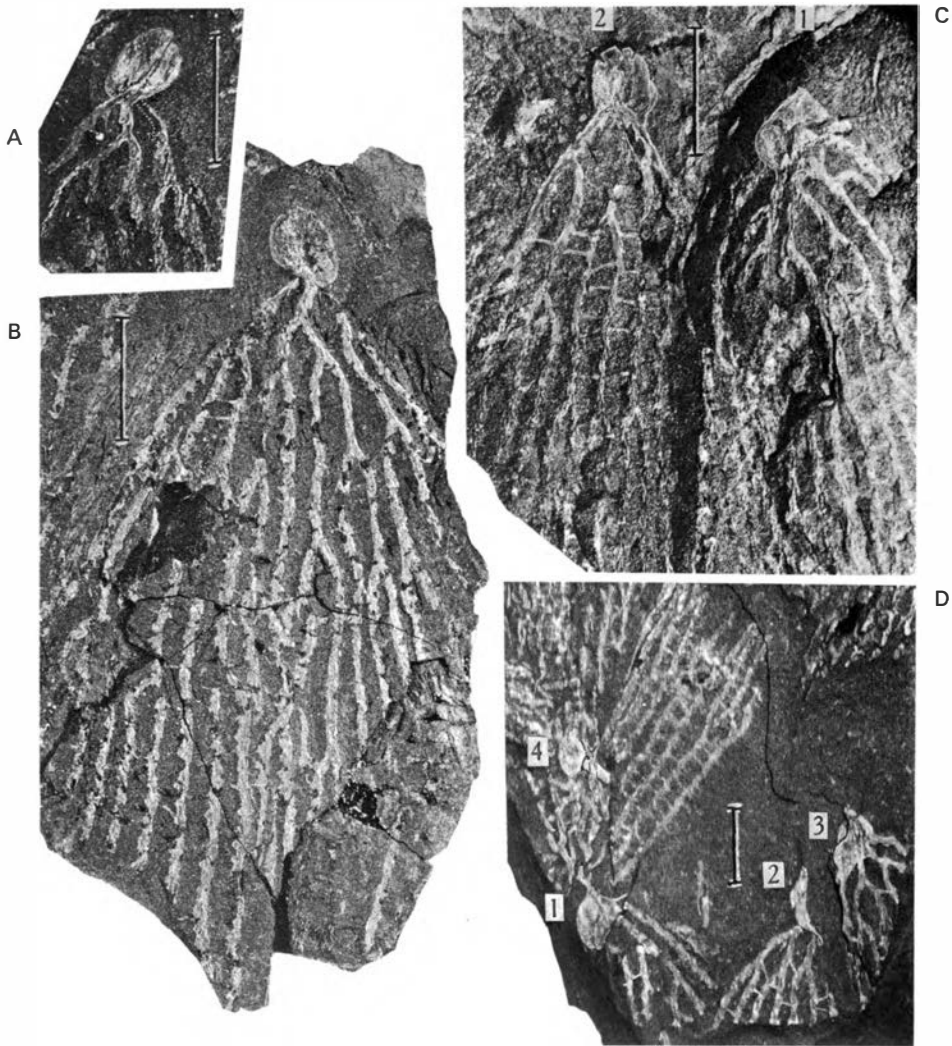


Fig. 1. *Dictyonema flabelliforme flabelliforme* (Eichwald), *Dictyonema* Shales, 2e, Bygdøy Sjøbad, Oslo. A: P.M.O. 74584, x 3 approx.; B: P.M.O. 74583 (counterpart of A), x 3 approx.; C: P.M.O. 74587 (1&2), x 3 approx.; D: P.M.O. 74588 (1-4), x 1.5 approx. All figures slightly retouched; the black lines are 5 mm in length.

hundreds of examined specimens of *Dictyonema flabelliforme* show the cone-shaped rhabdosome originating in a free sicula' (Størmer 1933, p. 110); but clearly it can no longer be dismissed as a freak or a regenerative abnormality. It may be noted that this supplementary material comes almost exclusively from Bygdøy Sjøbad, like the original specimens described in 1933 and 1935; two examples, however, are known from Tøyen (several were present according to notes), one from Hammersborg, and one from Wales (the Gwynant Valley, near Cader Idris). Most of the examples are



Fig. 2. *D. f. flabelliforme* (Eichwald), *Dictyonema* Shales, Pont-ty-Gwyn, W. side of Gwynant Valley, Cader Idris, Wales. SM. A62260, x 4 approx. Slightly retouched; the specimen is somewhat compressed parallel to the axis of the rhabdosome.

referable to *D. f. flabelliforme* (Figs. 1&2), but there are also four specimens of *D. f. anglica* (Fig. 3) and three of *D. f. norvegica* (Fig. 4).

### Description

Although outlines are commonly sharp, fine detail is lacking and the interpretation of the three-dimensional nature of these 'basal organs' remains somewhat uncertain. In the majority of examples the basal structure appears



Fig. 3. *D. f. anglica* Bulman, *Dictyonema* Shales, 2e, Bygdøy Sjøbad, Oslo. A: P.M.O. 74585, x 4 approx.; B: P.M.O. 74587(3), counterpart of A, x 4 approx.; C: P.M.O. 65676, x 2 approx. All figures slightly retouched.

as a discoidal or leaf-shaped film arising from the bases of the primary stipes. The outline is rarely entire and the body commonly appears to have split, particularly near the apex. Some of these splits may well be preservational defects, particularly where the whole disc is fragmented (P.M.O. 74587(1) (Fig. 1C), also 74587(3) & 74585); but the frequency of occurrence suggests that whatever the nature of the original body, there is a tendency for splitting or disruption on flattening. It appears to us unlikely that the sicula is lost, either through damage or resorption, and replaced, or is in some manner obliterated by the 'basal organ'; but only in a few instances is there any detectable trace of the sicula within (P.M.O. 65676 (and counterpart 64574(1)), 74583, 74587(2) (Figs. 1C & 5B), 74588(5), 74589(1,2). The

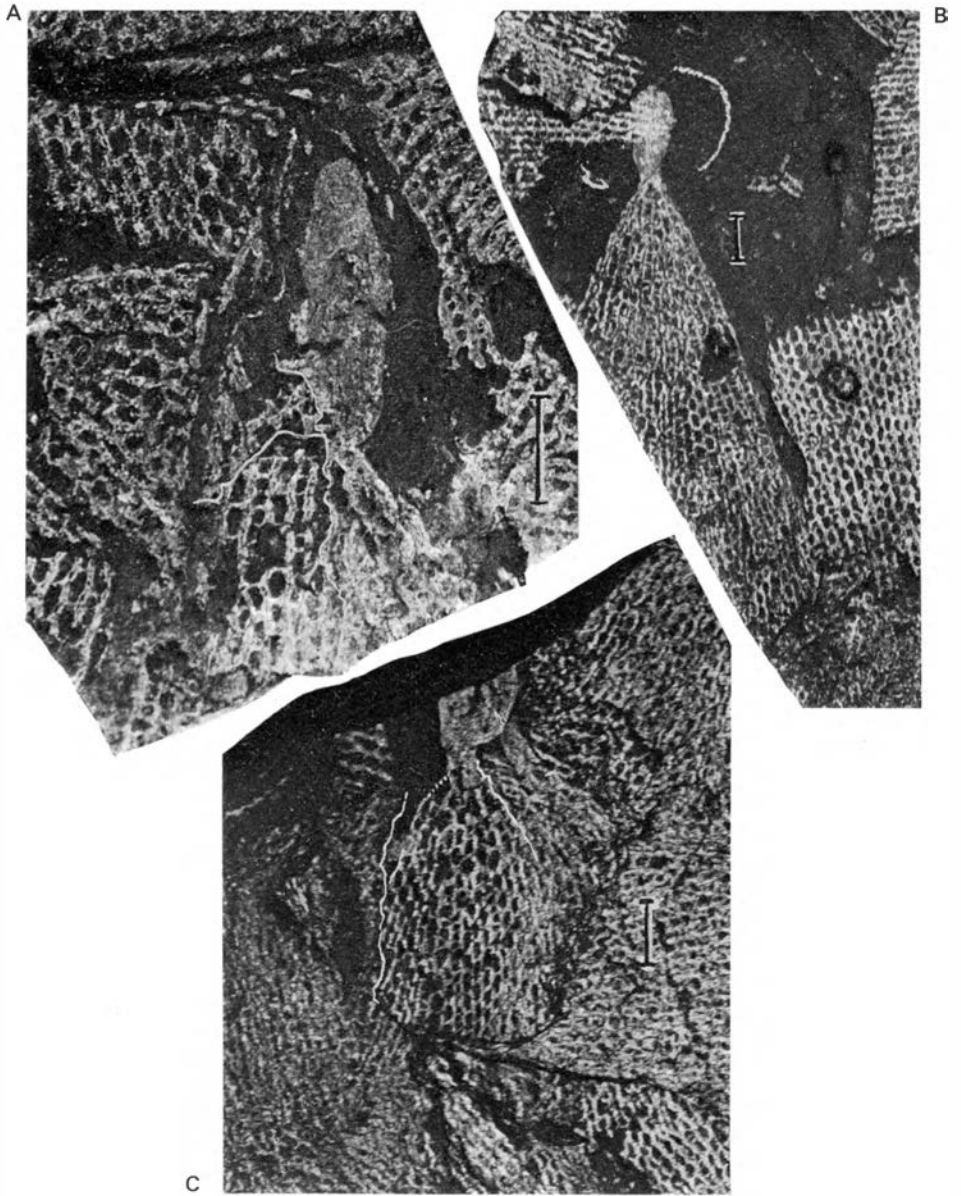


Fig. 4. *D. f. norvegica* (Kjerulf), *Dictyonema* Shales, 2e. A: P.M.O. 64995, x 2.75; Street section north of Geology Museum, Tøyen, Oslo. B: P.M.O. 65011, x 1.25; Hammersborg, Oslo. C: P.M.O. 61925, x 1.5 approx.; Sofienberg gate, Tøyen, Oslo. All figures slightly retouched.

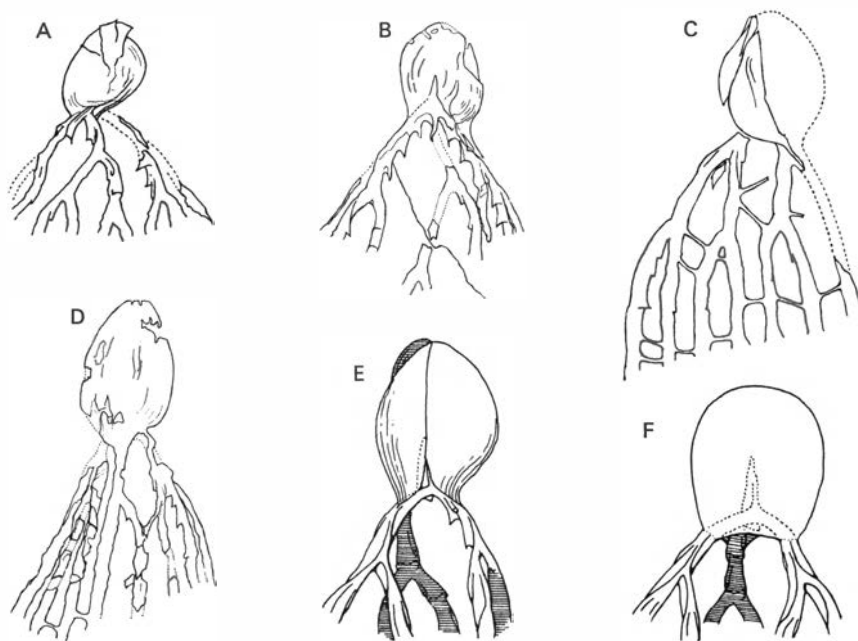


Fig. 5. A: *D. f. flabelliforme*, P.M.O. 74584, 2e, Bygdøy Sjøbad, Oslo, x 4 approx., showing distal splitting of 'basal organ' and growth-lines. B: *D. f. flabelliforme*, P.M.O. 74587 (2), 2e, Bygdøy Sjøbad, Oslo, x 4 approx., showing sicula, growth-lines and a suggestion of overlapping vanes on right based on 2 primary branches. C: *D. f. flabelliforme*, P.M.O. 74588 (2), 2e, Bygdøy Sjøbad, Oslo, x 4 approx; the 'basal organ' is incompletely preserved, but shows some indication of 2 distinct vanes on left side. D: *D. f. flabelliforme*, *Dictyonema* Shales near Cader Idris, SM. A62260, x 4 approx., with slight indication of growth-lines. E, F, diagrams illustrating alternative interpretations of the 'basal organ' as a vane structure or a sphaeroidal vesicle, respectively.

following discussion therefore assumes the presence of a sicula incorporated in or enclosed within the basal structure.

## Discussion

Two three-dimensional interpretations of these basal structures are possible; either they represent hollow bulb-like vesicles (Fig. 5F) which have been crushed flat, or they represent roughly semicircular vanes attached along a central axis and based on the dorsal edges of the primary branches (Fig. 5E), and, of course, again flattened. The former is the interpretation originally suggested, at a time when comparable structures on the virgula of biserial graptoloids were also considered to be 'vesicular'. But all known graptoloid 'floats' or 'vesicles' have now been shown to be composed of vanes, generally three in number and set at approximately  $120^\circ$  to one-another. This now seems the more probable interpretation of the *Dictyonema* 'floats'

also, and here the number of vanes may be related to the number (three or four) of primary branches. It must be admitted that there is no indication of the presence of a nema to which the vanes are attached along their inner edges, but two features are more readily explained on this interpretation.

The first of these features is the presence of what appear to be growth-lines, well shown in P.M.O. 74587(2) (Figs. 1C & 5B), less clearly seen in P.M.O. 74584, 74586 and 74588(3 & 4). They are more prominent near the base, where the vane (if such it be) arises from one of the primary branches, and have a slightly S-shaped course conforming to the outline of the vane. It is more difficult to account for these as wrinkles in an originally sphaeroidal structure; moreover, there is no indication of growth-lines parallel to the edge of the web apparently connecting the branches, which would be the growth zone had the structure been originally sphaerical. Anastomosing, radially disposed striae are rarely seen (P.M.O. 74587(1)).

The second feature is the asymmetry of the 'basal organ' and the conformation of the outer edge of certain specimens, which can be interpreted as a result of overlap of two lamellae or vanes. The best examples are P.M.O. 74587(2) (Figs. 1C & 5B) and 74588(2) (Fig. 1D), and less distinctive examples are P.M.O. 74584(1), 74587(3) and 74589(1). In P.M.O. 74587(1) and 74588(3) different patches of the disc at slightly different levels could again be interpreted as overlapping vanes, though a purely mechanical explanation cannot be excluded.

Whatever the interpretation of these cuticular structures, the actual buoyancy would be due to the presence of gas or air bubbles trapped in a more or less sphaerical mass of living tissue surrounding the sicula or situated at the apex of the sicula, and secreting either vane like partitions or a cuticular envelope.

ACKNOWLEDGEMENTS. Photographs of the Norwegian specimens, except Fig. 1C, were taken by Miss Bergljot Mauritz; Fig. 1C and Fig. 2 are by Mr. David Bursill.

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